STATUS REPORT

Grant SC - NSG - 407

For the period 25 October 1964 - 25 October 1965

Yale

1. Introduction

The Yale Observatory has since 1957 engaged in a systematic observation program relating to the decametric radio emission from Jupiter. This complex radiation, even now not fully understood, is strong, sporadic and rapidly time-varying. The emission is narrow-band and exhibits both random and systematic frequency drifts; it is directive but with dramatically changing directivity properties as a function of frequency. Probability of observing its emission is strongly correlated with the geometrical configuration of Jupiter, earth and Jupiter's innermost Gallilean satellite Io, and furthermore varies over a 10 - 12 year period due to some as yet unexplained sun spot or orbital configuration influence.

The radio emission is strongly polarized; NSG-407 and its predecessor have supported the development at Yale of a multi-channel polarization analyzer capable of high speed operation to systematically study its polarization characteristics. Such studies are complicated by the optical activity of the earth's ionosphere at these wavelengths; pronounced and time varying distortions of the observed polarization characteristics may be produced; such variations have been discovered and noted in previous status reports.

In addition to ionospheric effects, important propagation phenomena may arise in the interplanetary medium. Two-station observations of the time variation of Jupiter's flux led us to propose in 1962 that the most important component of time variation was due to a diffraction process in the interplanetary medium, and pointed out that studies of this time structure can lead to knowledge of the scale size, shape, density and velocity of the responsible inhomogeneities in the interplanetary medium.

It was therefore of particular interest to note that the fast changes in axial ratio occasionally observed in our polarization work occurred with the same kind of time scale as the interplanetary scintillations. At this point, NASA support of continued and expanded time structure observations from several stations was requested and obtained, under Supplement 1 of the present grant.

Progress on polarization and interplanetary medium studies during the period of this status report is described in following sections.

2. Polarization Studies

A. Observations

Our long-standing program of systematic low and high speed monitoring of polarization properties of Jupiter's decametric emission was continued during the report period. Several instrumental improvements followed the completion of an analysis phase described in the previous status report: calibration procedures were modified and expanded to permit a more certain knowledge of all relevant instrumental parameters, and a third, medium speed recording system was placed in parallel with the existing high and low speed recorders. Certain electronic modifications to the equipment to improve linearity were made, and impedance and balance of the antenna system was re-measured.

During the report period, observations were obtained during approximately 90% of the possible observing time; a larger number of well-recorded Jupiter storms await analysis.

B. Data Analysis

Dr. K. W. Philip continued his analysis of high speed records of Jupiter storms, extending and confirming results reported in the last status report. It is clear that to distinguish between Jovian and interplanetary origin of the fast polarization variations will require polarization observations at sites spaced about 100 km apart, in conjunction with flux time structure observations. Such a spaced polarization analyzer, requested in our last proposal for grant renewal, has not been installed for reasons described in Section 4.

Several years of low-speed polarization data have been analyzed by Philip to obtain average axial ratios for all recorded Jupiter storms; these interesting data are now being incorporated into a forthcoming publication describing results of the entire synoptic monitoring phase of the Yale program.

3. Observations of the Interplanetary Medium

With the support of the present grant, a third high-speed flux monitoring station has been added to the two now in existence, providing via telephone lines high speed records of Jupiter flux observed at two points 100 and 60 km from the main observing station. This station, in operation since March 1965, has provided information extending and confirming results obtained earlier with the two-station system. Specifically, the 1-second variations characteristically seen in the flux of Jupiter radiation are found to be due to electron clouds moving radially outward from the sun at velocities in the range 400-1000 km/sec. These clouds, having sizes on the order of

500 km, produce no effect on flux from the brighter radio sources due to the small angular size of the clouds (1" - 2") compared to the diameter of the radio sources. The decameter source on Jupiter must be quite small (much less than 2") to be so completely modulated by this interplanetary scintillation mechanism.

The third station permits an unambiguous determination of the projected velocity of the clouds' motion. In a preliminary reduction, L. P. Pataki has found that our initial hypothesis of purely radial motion of the clouds away from the sun is confirmed by the three stat on observations. Observations now in hand from this three-station network will permit a rough determination of average cloud shape; this laborious analysis is now underway.

A primary obstacle in the way of full utilization of this powerful new technique for studying the interplanetary medium is the time and labor required in the reduction of our high-speed analog records to numbers which may then be computer-analyzed; requests to NASA for permission to use current grant funds to provide a high-speed digitizer are pending.

4. Future Plans

The principal investigator resigned from Yale University in September 1965 to become Associate Professor of Astronomy at The University of Texas. However, in the interest of continuing this very important work, both Yale and Texas approved a continuing appointment as Research Associate at Yale. Day-to-day observations are carried out by competent graduate students; frequent trips by the principal investigator to Yale are made.

A proposal to NASA from The University of Texas to permit continuation of this interesting work at Texas is pending; Yale has agreed to transfer all equipment to Texas after observations stop in New Haven (June 1966). This pending transfer resulted in a decision not to install the spaced polarimeter receiver as provided for in the present grant; such an instrument is very difficult to move. Savings from this and other budget items permit the above-referenced pending request to NASA to permit acquisition of a high-speed digitizer system which could be very easily transferred to Texas and would vastly facilitate all phases of the continuing work.

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